

## CCXIV. A SURVEY OF ANTHOCYANINS. VI

BY JAMES ROBERT PRICE AND VIOLET CELIA STURGESSION

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IN earlier parts of this series [Robinson & Robinson, 1931; 1932; 1933; 1934; Lawrence *et al.* 1938] the nature of the anthocyanins present in the flowers, fruits, permanently pigmented leaves and autumn leaves of many species of plants has been described. To complete the analysis of the distribution of the principal anthocyanin types in the Angiosperms, a series of young leaves has now been examined. In young leaves coloration due to anthocyanins, disappearing with maturity, is a phenomenon which is probably more general than autumnal anthocyanin development, and the (approximately) 200 species, in 110 genera, tested were chosen to cover as wide a range of plants as possible.

As in autumn leaves, cyanidin saccharides predominate, being found in 93 % of the genera. In a few cases, other constituents interfered with the colour reactions and distribution, rendering it difficult to identify the glycosidal type definitely. But in those genera which contained cyanidin derivatives whose sugar types were determined, there were found:

|                        |                     |
|------------------------|---------------------|
| 31 % monoglycosides    | 30 % 3-biosides     |
| 50 % pentoseglycosides | 9 % 3:5-dimonosides |

A comparison of the figures with those derived from autumn leaves, flowers etc. will be made in a later communication.

### Results

Figures refer to the numbers given by Hutchinson [1926] in his classification of the flowering plants, the first indicating the order and the second the family, e.g. 76-264 order Lamiales, family Labiateae. For completeness two plants have been included which were recorded previously, namely *Impatiens biflora* and *Crataegus oxyacantha fl. pl. rosea* [Robinson & Robinson, 1932].

### Dicotyledons

|         |   |   |         |  |   |
|---------|---|---|---------|--|---|
| 76-264. | <i>Ajuga reptans</i> var. <i>atropurpurea</i> | o | 67-238. | <i>Aster ericoides</i>                                     | j |
|         | <i>Elsholtzia Stauntonii</i>                  | b |         | <i>Silphium perfoliatum</i>                                | d |
|         | <i>Lamium purpureum</i>                       | d |         | <i>Solidago aurea</i>                                      | g |
|         | <i>Salvia nemorosa</i>                        | o |         | <i>Sonchus oleraceus</i>                                   | a |
|         | <i>S. officinalis</i>                         | k | 66-233. | <i>Abelia chinensis</i>                                    | n |
|         | <i>S. virgata</i>                             | m |         | <i>Lonicera Ferdinandii</i>                                | j |
| 76-263. | <i>Callicarpa koreana</i>                     | g |         | <i>L. Maackii</i>  | g |
|         | <i>Clerodendron foetidum</i>                  | a |         | <i>L. Periclymenum</i>                                     | j |
|         | <i>C. trichotomum</i>                         | a |         | <i>L. Periclymenum</i> var. <i>belgica</i>                 | j |
|         | <i>Petraea volubilis</i>                      | v |         | <i>L. pileata</i> var. <i>yunnanensis</i>                  | g |
| 75-257. | <i>Bignonia Unguis-cati</i>                   | g |         | <i>Symporicarpus orbiculatus</i> var. <i>conglomeratus</i> | g |
| 75-256. | <i>Streptocarpus Rexii</i>                    | q |         | <i>S. occidentalis</i>                                     | g |
| 75-252. | <i>Pentstemon procerus</i>                    | l |         | <i>Viburnum betulifolium</i>                               | o |
|         | <i>Veronica Chamaedrys</i>                    | j |         | <i>V. fragrans</i>   | a |
| 74-250. | <i>Solandra Hartwegii</i>                     | c |         | <i>V. Opulus</i> var. <i>sterile</i>                       | h |
| 69-241. | <i>Ceratostigma plumbaginoides</i>            | y |         | <i>V. rugosum</i>  | d |
|         | <i>C. Willmottianum</i>                       | x |         | <i>V. Tinus</i> var. <i>hirtum</i>                         | h |
|         | <i>Limonium latifolium</i>                    | A |         | <i>Apocynum cannabinum</i>                                 | d |
| 69-240. | <i>Dodecatheon Meadia</i>                     | o | 65-230. | <i>Jasminum officinale</i>                                 | d |
|         | <i>Steironema ciliatum</i>                    | w | 64-229. |  |   |

|         |   |    |  |   |
|---------|---|----|--|---|
| 64-229. | <i>Jasminum primulinum</i>                          | d  | <i>Spiraea arborea</i>                                     | a |
|         | <i>J. revolutum</i>                                 | e  | <i>S. japonica</i> var. <i>Bumalda</i> , Anthony           | d |
|         | <i>Ligustrum Quihoui</i>                            | h  | <i>Waterer</i>   |   |
|         | <i>L. sinense</i>                                   | d  | <i>S. japonica</i> var. <i>ruberrima</i>                   | e |
|         | <i>Osmanthus Delavayi</i>                           | f  | <i>S. media</i>  | d |
|         | <i>Syringa Sveginzowii</i> var. <i>superba</i>      | h  | <i>S. Sargentiana</i>                                      | b |
|         | <i>S. vulgaris</i>                                  | f  | <i>Stephanandra incisa</i>                                 | d |
| 60-216. | <i>Agapetes buxifolia</i>                           | b  | <i>Stranvaesia Nussia</i>                                  | b |
|         | <i>Pentapterygium serpens</i>                       | a  | <i>S. salicifolia</i>                                      | d |
|         | <i>Vaccinium caespitosum</i>                        | a  | <i>S. undulata</i>   | a |
|         | <i>V. pennsylvanicum</i>                            | A  | 39-142. <i>Deutzia scabra</i>                              | g |
|         | <i>V. virginatum</i>                                | a  | <i>Hydrangea petiolaris</i>                                | e |
| 60-215. | <i>Erica cinerea</i>                                | a  | <i>Philadelphus Wilsonii</i>                               | g |
|         | <i>Macleania insignis</i>                           | a  | 39-141. <i>Ribes aureum</i>                                | d |
|         | <i>Pieris japonica</i>                              | a  | <i>R. lacustre</i>   | b |
| 60-214. | <i>Clethra arborea</i>                              | d  | <i>R. speciosum</i>  | a |
| 59-213. | <i>Bupleurum fruticosum</i>                         | a  | 39-139. <i>Escallonia edinensis</i>                        | d |
| 59-212. | <i>Hedera Helix</i>                                 | g  | 35-130. <i>Tarrietia Argyrodendron</i>                     | p |
| 57-200. | <i>Acer cappadocicum</i> var. <i>rubrum</i>         | a  | 35-128. <i>Elaeocarpus obovatus</i>                        | d |
|         | <i>A. Ginnala</i>                                   | d  | 34-123. <i>Hypericum hircinum</i>                          | b |
|         | <i>A. palmatum</i> var. <i>septemlobum elegans</i>  | d  | <i>H. Hookerianum</i>                                      | a |
| 57-198. | <i>Koelreuteria paniculata</i>                      | g  | <i>H. lysimachioides</i>                                   | d |
| 55-194. | <i>Skimmia japonica</i>                             | a  | <i>H. patulum</i> var. <i>Forrestii</i>                    | a |
| 54-193. | <i>Vitis Henryana</i>                               | B  | 33-118. <i>Acmena floribunda</i>                           | v |
| 51-173. | <i>Euonymus oxyphyllus</i>                          | i  | <i>Callistemon citrinus</i> var. <i>splendens</i>          | l |
| 51-171. | <i>Ilex Aquifolium</i>                              | d  | <i>Eugenia rupestris</i>                                   | l |
| 50-169. | <i>Urtica dioica</i>                                | h  | <i>Myrtus communis</i>                                     | C |
| 43-156. | <i>Populus monilifera</i>                           | d  | <i>M. communis</i> var. <i>tarentina</i>                   | A |
| 42-151. | <i>Hamamelis japonica</i> var. <i>flavopurpurea</i> | z  | 32-114. <i>Ochna multiflora</i>                            | e |
|         |   |    | 32-108. <i>Eurya ochracea</i>                              | d |
| 42-150. | <i>Stachyurus praecox</i>                           | g  | 30-104. <i>Begonia glaucophylla</i>                        | g |
| 41-148. | <i>Physostegia virginiana</i>                       | g  | 24-85. <i>Hibbertia volubilis</i>                          | b |
| 40-145. | <i>Calycanthus floridus</i>                         | d  | 21-77. <i>Epilobium hirsutum</i>                           | l |
| 40-143. | <i>Amelanchier canadensis</i>                       | d  | 32-114. <i>Fuchsia magellanica</i> var. <i>Riccartonii</i> | d |
|         | <i>Aronia melanocarpa</i>                           | d  | <i>F. magellanica</i> var. <i>corallina</i>                | r |
|         | <i>A. arbutifolia</i>                               | e  | <i>Oenothera fruticosa</i> var. <i>Youngii</i>             | g |
|         | <i>Cotoneaster acutifolia</i>                       | d  | <i>Oe. glauca</i> var. <i>Fraseri</i>                      | n |
|         | <i>C. bullata</i>                                   | a  | 21-75. <i>Punica granatum</i> var. <i>flore pleno</i>      | l |
|         | <i>C. Dielsiana</i>                                 | d' | 20-71. <i>Impatiens biflora</i>                            | d |
|         | <i>C. horizontalis</i>                              | a  | 18-57. <i>Polygonum baldschuanicum</i>                     | d |
|         | <i>Crataegus congestiflora</i>                      | a  | <i>P. polystachyum</i>                                     | d |
|         | <i>C. oxyacantha</i> var. <i>flore pleno rosea</i>  | d  | <i>P. Sieboldii</i>  | d |
|         | <i>Cydonia japonica</i>                             | d  | <i>Rumeza alpinus</i>                                      | b |
|         | <i>C. lagenaria</i>                                 | d  | 13-42. <i>Polygala vulgaris</i> var. <i>serpyllacea</i>    | g |
|         | <i>C. lagenaria</i> var. <i>aurea</i>               | d  | 5-19. <i>Berberis chitria</i>                              | d |
|         | <i>Exochorda racemosa</i>                           | g  | <i>B. Lycium</i>   | d |
|         | <i>Malus baccata</i> var. <i>Jackii</i>             | e  | <i>B. pruinosa</i>   | w |
|         | <i>M. pumila</i> var. <i>Niedzwetzkyana</i>         | a  | <i>B. Thunbergii</i>                                       | d |
|         | <i>M. Sieboldii</i>                                 | b  | <i>B. Verna</i>  | b |
|         | <i>M. yunnanensis</i> var. <i>Vietchii</i>          | a  | <i>B. virescens</i>  | d |
|         | <i>Neillia longiracemosa</i>                        | d  | <i>Mahonia aquifolium</i>                                  | d |
|         | <i>N. opulifolia</i> var. <i>lutea</i>              | b  | 4-15. <i>Anemone nemorosa</i>                              | g |
|         | <i>Photinia serrulata</i>                           | e  | <i>Caltha palustris</i>                                    | g |
|         | <i>Poterium tenuifolium</i> var. <i>album</i>       | n  | <i>Cimicifuga racemosa</i>                                 | f |
|         | <i>Prunus cerasifera</i> var. <i>Blirieana</i>      | d  | <i>Clematis Armandii</i>                                   | g |
|         | <i>P. cerasifera</i> var. <i>Moseri</i>             | d  | <i>C. Armandii</i> var. <i>La Mortola</i>                  | g |
|         | <i>P. serrulata</i> var. <i>forma</i>               | d  | <i>C. recta</i> var. <i>purpurascens</i>                   | g |
|         | <i>P. serrulata</i> var. <i>pubescens</i>           | d  | <i>Paeonia Darius</i>                                      | s |
|         | <i>Pyracantha atlantoides</i>                       | d  | <i>P. Emodi</i>  | u |
|         | <i>Pyrus purpurea</i>                               | a  | <i>P. Emodi</i> var. <i>lobata</i>                         | s |
|         | <i>Raphiolepis indica</i>                           | a  | <i>P. suffruticosa</i>                                     | u |
|         | <i>Rosa Banksiae</i>                                | j  | <i>P. trolloides</i>                                       | t |
|         | <i>R. filipes</i>                                   | h  | <i>Thalictrum glaucum</i>                                  | j |
|         | <i>R. multiflora</i> var. <i>cathayensis</i>        | i  | <i>Doryphora Sassafras</i>                                 | e |
|         | <i>R. omeiensis</i> var. <i>praecox</i>             | d  | 3-10. <i>Drimys Winteri</i>                                | d |
|         | <i>Rubus thysiger</i>                               | o  | 1-2. <i>Manglietia Hookeri</i>                             | u |
|         | <i>Sorbus hupehensis</i> var. <i>rosea</i>          | a  |  |   |

*Monocotyledons*

|                                  |   |                               |   |
|----------------------------------|---|-------------------------------|---|
| <i>Acorus Calamus variegatus</i> | d | <i>Tradescantia bracteata</i> | g |
| <i>Alpinia Sanderae</i>          | d | <i>T. virginiana</i>          | g |
| <i>Lilium regale</i>             | d |                               |   |

*Hybrids*

|  |   |                               |   |
|--|---|-------------------------------|---|
| <i>Cistus corbariensis</i>             | a | <i>Phlox Coquelicot</i>       | o |
| <i>Diervilla hybrida</i>               | d | <i>Raphiolepis Delacourii</i> | e |
| <i>Lychnis Arkwrightii</i>             | c | <i>Tritonia G. Davison</i>    | n |
| <i>Philadelphus purpureo-maculatus</i> | g |                               |   |

*Bouganvillaea*, Mrs Butt, young leaves contained a nitrogenous anthocyanin with behaviour similar to that found in the bracts [Price & Robinson, 1937].

- a Cyanidin 3-monoside.
- b Cyanidin monoside.
- c Cyanidin 3-monoside + a little diglycoside.
- d Cyanidin 3-PG.
- e Cyanidin PG.
- f Cyanidin 3-PG + a little diglycoside.
- g Cyanidin 3-bioside.
- h Cyanidin 3-bioside + cyanidin 3-PG.
- i Cyanidin 3-bioside + cyanidin 3-monoside.
- j Cyanidin 3:5-dimonoside.
- k Acylated cyanidin 3:5-dimonoside.
- l Cyanidin diglycoside.
- m Acylated cyanidin diglycoside.
- n Cyanidin diglycoside + cyanidin monoside.
- o Cyanidin diglycoside + cyanidin PG.
- p Cyanidin saccharide with very high distribution.
- q Cyanidin 3-bioside + PG possibly containing some malvidin.
- r Peonidin 3-bioside + some cyanidin 3-bioside.
- s Peonidin 3:5-dimonoside + some peonidin monoside.
- t Peonidin 3:5-dimonoside.
- u Peonidin 3:5-dimonoside + some cyanidin 3:5-dimonoside.
- v Malvidin 3:5-dimonoside.
- w Malvidin PG.
- x Malvidin 3-PG + trace Fe<sup>+</sup> anthocyanin.
- y Malvidin 3-PG + some cyanidin 3-PG.
- z Malvidin 3-bioside + cyanidin 3-bioside.
- A Delphinidin 3-PG.
- B Delphinidin diglycoside + delphinidin PG.
- C Malvidin 3-PG + delphinidin 3-PG.

(PG = pentoseglycoside.)

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